solplan review

the independent newsletter of energy efficient building practice

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No. 28 August-September 1989

Inside . . .

Cellulose insulation is being used more frequently today. Proponents often make wild claims in support of their product. But just how valid are the claims? Recently, several tests have been done on cellulose insulation. We present the findings of several.

Cellulose insulation has been claimed as being an airtight insulation product. Tests done for the NAHB suggest that the blown-in-batt application of this insulation does give a more airtight wall assembly.

Use of loose fill blown cellulose insulation in attics in Manitoba has become common. But the Manitoba Housing Corporation has had problems due to moisture accumulation in the attics, so they commissioned Professor Ray Chant at the University of Manitoba to investigate.

Cellulose manufacturers in Canada funded a demonstration project to show one way to use loose fill insulation in walls. We present the results of the demonstration.

Rehabilitation of existing housing can upgrade the quality of housing and extend the useful life of homes for a fraction of the replacement cost. It also improves their comfort. We present a report on a retrofit project in Northern Ontario.

We are becoming aware of the importance of environmentally clean buildings. We review two recent books that help you do it properly.

It was a wonderful trip to Scandinavia. Your editor presents a few thoughts on what he observed. Other items include a variety of brief items on new products and services.

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Cellulose Insulation

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Richard Kadulski

From the Publisher

Foreign travel can be fun and is enlightening. It also gives you the chance to stand back and reflect on your own situation from a perspective that you don't always get at home.

I had heard a lot of good things about the Swedish building industry before going to Sweden. It does make a good product and there is no doubt we can learn a lot from them. I am now also convinced that we in Canada don't have to take a back seat to anyone.

We have a world class building science expertise, and a good core of experienced and knowledgeable builders (in part, thanks to the activities of the R-2000 program). But we suffer from the typical Canadian inferiority complex (until someone else tells us we're good, we won't believe it). We lack the willingness to take full advantage of that talent and expertise.

Our industry has an inability or is not willing to get the message of what quality really means out to the consumer. Quality is good workmanship, good design and *doing what is technically correct*. We should be stressing the importance of it even if it means that the fourth toilet or the pink tub with gold plated taps may have to be given up. Homes are not just another disposable gadget; they must be built for long term durability.

Product manufacturers must be willing to develop or improve better products. They usually wait for the "marketplace" to call for them, but if the products don't exist, how can the marketplace communicate the need for them (or do we need to mandate product improvement)?

The Swedish housing industry has received much good press in large part because the industry has a strong voice promoting the industry in a cooperative manner. As well, the industry has larger players, it is not fragmented like ours, and is willing to meet the challenges it faces. We have many small players who don't always have the resources to mount major promotional efforts.

One problem may be that some of our larger players are controlled by foreign companies, and don't have the mandate or willingness to develop new products or promote exports. Another may be a lack of entrepreneurial get-up and go to educate the marketplace and promote quality.

Richard Kadulski
Publisher

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Cellulose Insulation (1):
Blown-In-Blanket insulation: How airtight is it?

The Blown-In-Blanket (BIBS) is a patented insulation system that has gained popularity in the building industry in the USA during recent years. BIBS combines standard loose insulation materials (fibreglass, rockwool, or cellulose) with a latex adhesive binder. It allows builders to install a custom-fit insulation job that reduces that gaps and void areas found when using other insulating methods.

But are the site installed loosefill insulation products really better than factory produced products (like batts or boards) that have uniform quality control? Obviously, each manufacturer promotes his product over all others.

Recent research tests supervised by the NAHB National Research Center (USA) looked at wall systems insulated with pre-made factory batts and BIB insulation systems. The results show that the blown-in-blanket systems are up to 3 times more airtight than identical wall systems insulated with factory made batts.

The tests were conducted on five full-scale wall sections using two insulation methods: one with standard factory made fibreglass batts and the other with the BIB System.

Because of the binder addition, the BIBs batt does not shift or settle, should last the lifetime of the structure, and is absent of costly voids. (The Manville Corp. has reported that a 4% void area in R-19 insulation coverage can lead up to a 50% heat loss.) With a properly installed BIB this problem is eliminated.

The tests compared both 5½" and 3½" wall systems following standard test procedures (ASTM E283 "Rate of Air Leakage"). This involves mounting the walls into a test chamber where a fan-induced pressure difference across the wall can be accurately measured. The effective leakage of each of the walls was assessed by measuring the air flow rate under different test pressures.

The standard conditions for air leakage tests is at a pressure difference of 50 Pascals (0.20 inches of water). This corresponds to a constant 20 mile-per-hour wind acting on the wall. In both the 5½" and 3½" walls, the conventional batt insulated walls had about three times more air infiltration than the BIBs walls.

This standard reporting condition illustrates a constant pressure difference not typically seen in a residential environment. However, it provides a good comparison of the relative leakage of the walls.

The 3½" test wall using R-11 batt installed to manufacturers instructions allowed 6.3 cubic feet per minute (cfm) of infiltration, versus 2.7 cfm for the 3½" BIBs wall.

The 5½" test wall with R-19 fibreglass batt passed 7.3 cfm while the 5½" BIBs wall passed 2.2 cfm.

But does this really mean something significant? It is important to keep in mind that though air infiltration may account for as much as 50% or more of a building's heating and cooling loads, the actual amount of air leakage through the wall may be very small. The main paths for air leakage are around window and door frames, electrical outlets, top and bottom plates, poorly fitting and loose construction, and through damage in finished building materials. Other studies by the NAHB Research Center have shown that in controlled laboratory tests, the total wall leakage through electrical outlets may be as much as 30%.

These data do show, however, that the infiltration component through the walls may be reduced by use of either of the materials and wet mix adhesive as applied in the BIBs technique. There may also be significant acoustical performance variations between the two wall insulation systems. The effect of damage to sheathing or other materials may also contribute to higher amounts of through-the-wall leakage.

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Cellulose Insulation (2)
Loose-fill Attic Insulation in Manitoba Housing

R.E. Chant

The cold climate in Manitoba, and recent emphasis on energy conservation, means that higher levels of insulation are now used. The practice that has developed is to blow loose-fill insulation into the attic to a depth of about 15 inches. This settles to a depth of 11 to 12 in. The total thermal resistance for this depth varies between R30 and 35 depending on the density (which is influenced by the moisture content).

A study to evaluate the performance of blown loose-fill cellulose fibre as an attic insulating material for wood-frame dwellings was undertaken for Manitoba Housing Corporation as they have frequently encountered wet insulation in attics. More maintenance problems concerning wet cellulose fibre have been brought to their attention than with glass fibre insulation. In some casaes it has been necessary to replace the cellulose insulation.

To evaluate the performance of cellulose fibre insulation under adverse conditions a method was developed to compare the performance of this loose-fill material to a competing product (loose-fill glass fibre) under identical conditions. What was considered was how the thermal and physical properties deteriorated and then recovered under conditions that may be encountered in the application for which they were intended.

A literature review revealed that only normal migrating moisture had been investigated. That is, the movement of moisture when the insulating materials are exposed to moisture levels which occur due to poor vapour barriers and/or to high relative humidities. The maximum moisture content reported was 20% by weight.

Sources of moisture also include drifting snow and other moisure movement driven by nasty weather conditions. As it may not be possible to guarantee that the insulation will always remain dry, the recovery rate of the thermal resistance when it dries is significant. Thus this study tried to determine what a realistic moisture content is, the time required for recovery, and the degree of thermal resistance recovery.

Full-scale prototype samples simulated 2x8 ceiling joists on 24 in. centres. The researchers then:

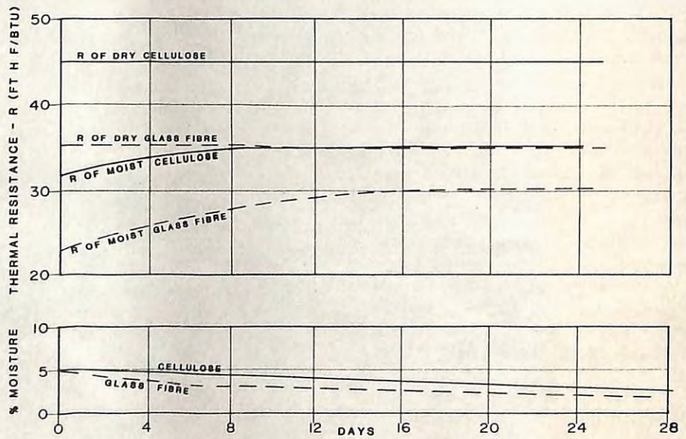
* measured the dry density of blown samples of cellulose fibre and glass fibre insulation;
* vibrated the samples to simulate installed conditions and to measure the density;
* measured the R values of the samples of cellulose fibre and glass fibre under dry 'as received' conditions;
* measured the R values of of cellulose fibre and glass fibre containing 5% moisture content (MC) by volume. This simulated wet condition was obtained by misting the samples, then sealing and storing for five days allow the moisture to penetrate evenly.
* exposed the samples tested at 5% MC to atmospheric conditions for five days, measured the density, then redetermined the R values.

To find out how much moisture would be absorbed, a sample was placed in an aquarium tank and wetted. Observations noted during the tests included:

The absorption of moisture by the cellulose fibre was accompanied by a considerable volume reduction (5% MC caused a 10% volume reduction)

Only 2% MC was adsorbed by the glass fibre before droplets appeared on the sides and bottom of the aquarium.

The moisture (5% MC) applied slowly in the form of a mist to the cellulose fibre penetrated six inches in the first four or five days and little additional penetration was obtained after that period.



THERMAL RESISTANCE VS DRYING TIME AND MOISTURE CONTENT

Upward migration of moisture from the bottom of the aquarium in cellulose fibre was extremely slow - four to five weeks for a six-inch penetration.

With the low density of glass fibre in loose fill no upward moisture movement was observed.

The major finding was that although the absolute values of the R values were higher for cellulose fibre under all conditions, the percentage recovery of the thermal resistance for the glass fibre was greater. After a 25 day drying period under normal environmental conditions (20°C and 30% RH), the thermal resistance of the glass fibre was 86% of the dry, "as received" thermal resistance while thermal resistance the cellulose fibre of was 78% of the dry value after drying under identical conditions.

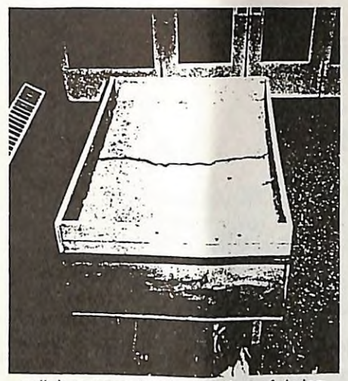
It was noted that loose-fill attic insulations (cellulose and glass fibre) when wet (5% MC by volume) will not dry during winter conditions in climatic conditions similar to those encountered in Manitoba, that is at a ceiling temperature up to 27°C and attic temperature of 0°C.

In other words, no drying of wet insulation will happen during the winter. It was also noted that at least two months is required to dry wet insulation in the summer under normal environmental conditions. Undoubtedly drying would be accelerated when attic temperatures reach 120° F (50°C) as often the case in the summer months.

The drying process appears to be completed within 25 days and there is little significant moisture retained to perpetuate any further damage to building materials.

However, shrinkage of the cellulose fibre samples was observed. It is possible that channelling of moisture would occur upon successive wettings if no maintenance was performed. Channelling of moisture was observed with less then 5% MC by volume in the glass fibre with both the aquarium investigations and the prototype samples.

Although the shrinkage with the encrustation of the cellulose fibre loose-fill insulation prototype samples is considered undesirable, the total thermal resistance is still greater than



cellulose sample after 25 days of drying

for fibre glass exposed to the same moisture content (5% by volume) and the moisture retention after drying is only slightly greater than for the glass fibre loose-fill insulation.

Channelling of moisture through cellulose fibre layers will undoubtedly occur on rewetting after an initial 5% by volume exposure to moisture; the moisture retention of loose-fill glass fibre insulation is of the order of 3.5% by volume and channelling of moisture through a 15 in. layer has been observed to occur in glass fibre when exposed to the 5% MC.

Roof Trusses, which have many metal truss plates that are covered with thick layers of blown cellulose fibre insulation have raised concerns over the corrosiveness of insulation. Other items which can corrode are electric junction boxes and pipes exposed to treated insulation.

Cellulose products marketed in Canada are required to pass the corrosive tests outlined in an ASTM standard specification for cellulose fibre insulation. However, there is some question as to whether the ASTM test is a realistic measure of corrosion as it does not simulate field conditions.

This is underlined by preliminary results of testing which indicate that some fire retardant salts used in cellulose are highly corrosive.

Borax and borax/boric acid treated cellulose (the most commonly used salts) have almost negligible corrosion (0.03%) but aluminum and ammonia sulfates treated cellulose fibres are at least 10 times as corrosive as the borax compounds.

INSULATION DENSITY
(dry loose-fill samples)

cellulose	2.5 lb/ft^3
glass fibre	1 lb/ft^3

After exposure of samples to humid atmospheric conditions for five weeks and vibrating:

cellulose	3.5 lbs/ft^3
glass fibre	1.35 lbs/ft^3

R-VALUES
(R-value of the 15" sample under dry conditions)

cellulose	R45
glass fibre	R35

(under wet conditions - 5% MC)

cellulose (a 29% reduction)	R32
glass fibre (a 34% reduction)	R23

(R-value of samples exposed to summer conditions (21°C and 40 to 50% RH) for 25 days)

cellulose	R35
glass fibre	R30

This summarizes "An Evaluation of Cellulose Fibre loose-fill Attic Insulation for Manitoba Housing" prepared by Prof. R. E Chant, Dept. of Mechanical Engineering, University of Manitoba for the Manitoba Housing Corporation.

Cellulose Insulation (3)

Blown-in batt approach (2)

Blown insulation in the walls of new construction is not allowed under some Canadian building codes, mainly due to concerns about the ability to inspect the installed insulation to ensure complete coverage and uniform density in all locations.

To demonstrate the feasibility of these construction techniques, the Cellulose Insulation Manufacturers' Association of Canada (CIMAC) sponsored the construction of an R2000 developmental home. The object was to demonstrate one approach to using blown cellulose insulation. The entire house (except for the floor) was insulated with blown dry insulation. The house was monitored from November 1986 to November 1987.

The main goal was to determine whether the cellulose insulated house would perform as required for R-2000 approval. Another concern was whether the insulation would interfere with the normal drying process of the newly-constructed walls.

Monitored items included:

** wall blowing procedures to determine how easy it would be to inspect for completeness of coverage and uniformity of insulation density;*
** moisture content of the framing material and insulation;*
** air flows of the heat recovery ventilator;*
** energy consumption for the heating, domestic hot water and other systems;*
** thermal integrity of the building envelope using an infra-red thermographic camera (twice, at one year intervals);*
** radon, formaldehyde and carbon dioxide levels over a one week period;*
** fan depressurization tests (performed twice).*

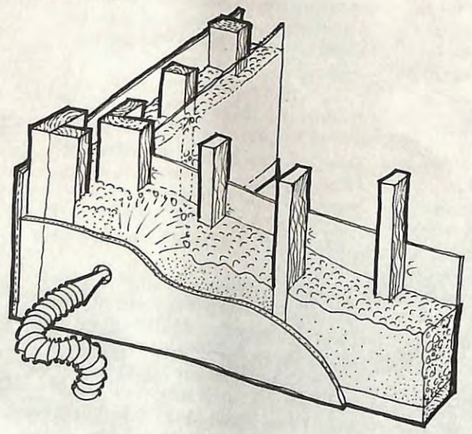
The cellulose house met all of the program requirements for certification as an R-2000 home. It was found to be adequately ventilated, very tight (approximately 0.4 ach @ 50 Pa) and within the energy budget.

The actual energy consumption was found to be 20% higher than predicted by HOT-2000 but most of the discrepancy was due to differences between standard R-2000 Program assumptions about how a home is occupied and run and actual operating conditions. The main differences were actual temperatures, ventilation rates and solar gains, all of which increased the energy consumption significantly.

The thermal integrity and airtightness did not change significantly over the one-year period.

The house

The demonstration house was built by Enersol Ltd. of Smith Falls, Ont. It is a 1,200 ft^2 bungalow over an insulated, preserved wood, crawlspace foundation. The above grade walls, ceiling and crawlspace walls are all insulated with blown cellulose insulation.



The construction

Perhaps the most original feature of the house are the walls. The construction was intended to provide a method of filling the walls with loose fill insulation in a uniform way.

The walls are a staggered stud arrangement. The 2"x4" outer studs and 2"x3" inner studs, each on 2 foot centres are attached to common top and bottom 2"x6". This staggered stud arrangement reduces thermal bridging through the wall and allows the insulation to flow around the studs during the filling operation. The corner detail also provides a free path for insulation flow and limits thermal bridges.

The outer surface of the wall is sheathed primarily with fibreboard. The inner surface of the cavity is a 6 mil polyethylene air vapour barrier attached to the studs by 2"x2" horizontal strapping on 16" centres. The joints in the polyethylene are overlapped, sealed with acoustical caulking and clamped with blocking. The inner surface is unsheathed for the insulating operation to allow the inspection of the insulation through the transparent vapour barrier.

About half of the ceiling area is covered with a conventional truss roof system with a horizontal bottom chord. The other half has a scissor truss arrangement to provide a cathedral ceiling effect. Over that portion of the ceiling, the loose insulation is actually resting on a slope.

Blowing Procedures

The vapour barrier of the walls and ceiling was in place and strapped. The blowing process was done in three stages:

1. Holes were drilled through the exterior sheathing at two-foot centres near the bottom of the wall. Insulation was blown in through these holes. Although this procedure filled most of the volume in the walls, high density was only achieved in the lower portion.

2. Another series of holes were drilled at two-foot centres near the top of the cavity. The space was filled until the overall density was judged to be adequate.

3. In areas of questionable density or coverage, additional holes were drilled and those specific areas were brought up to the desired level of density and coverage.

A total of 84 bags of insulation (30 pounds each) were used in the walls. By judging the amount of bulging of the polyethylene vapour barrier it was determined that the average depth of insulation was close to 6½ inches.

A visual inspection determined that the coverage looked to be consistent. Although there were some small variations in density and depth of insulation, no significant voids were observed.

The only areas where any leakage developed in the polyethylene vapour barrier during the blowing process were at the seams in the vapour barrier. These had not been properly strapped prior to the blowing process. The technique provided a very good way of judging the integrity of the vapour barrier since any leaks were visible.

Problems were encountered in the confined areas around windows, doors and especially the corners. These areas required the drilling of extra access holes.

Insulation Inspection

Access panels were placed in two closets of the house. These were removed to visually inspect the wall insulation at the beginning and end of the monitoring period. No indication of settling or moisture collection was noted.

The insulation was also visible through the polyethylene on the interior of the crawl space walls. No signs of moisture accumulation or insulation settling were noted in these areas.

What was found?

Thermographic scans were done at the beginning and end of the monitoring period. The thermal integrity of the building proved to be very good. The surface temperatures of the exterior walls were consistent.

The ceiling in the east side of the building was a "mock" cathedral ceiling with a roof structure made of scissor trusses. The insulation itself showed no deviation under thermographic scanning. However, there were problems with the two gable end walls in the area above the wall plate and below the ceiling. This area was insulated from the attic space by blowing insulation down into a framed out area. The area had not been inspected in the same way as the main walls, but surface area temperatures of the interior wall at these locations only had a maximum variation of 3°C from other interior surfaces.

Only the gable ends showed an insulation deficiency. These areas where insulated using the more conventional building practice of blowing insulation down from the top. The insulation in these areas did not meet the same uniformity of insulation density and completeness of coverage as did the wall sections.

One location where surface temperature variation was noted during the second survey was in some areas at the top of the kitchen/laundry room wall. This was an interior wall and the cold spots were attributed to air leakage. It was thought that there was some shrinkage of the caulking where wiring passed through the vapour barrier

The construction technique of the walls provided good insulation inspection capabilities and, in fact, provided a very good way of judging the integrity of the vapour barrier since any leaks were quite visible.

Moisture monitoring indicated that the moisture content of the studs and insulation dropped from construction conditions and remained well below rot conditions. The studs went from 13-17% to less than 9%; the insulation went from 16-24% to less than 12% (depending on location).

A lot of data on the performance of the house was collected. Some was typical monitoring data gathered for low energy home performance studies. But what was notable about the cellulose insulation as used in this project?

The main object was to address the ability to inspect the thermal and mechanical performance of the blown-wall insulating system. The system performed well over the year-long monitoring program. However, one year is a limited part of the life of a building; there could be other issues related to the use of such a system, and cellulose insulation in particular, which were not addressed by this project.

The construction type is not standard, so it would require special consideration. We are not certain how practical this type of construction may be. It seems like a lot of fussing, especially if the house had a shape more complex than a single rectangular box.

Alternate approaches to blown-in insulation may be easier to tie to conventional building practices.

This summarizes a the report "Cellulose Insulation Manufacturers' Association of Canada Development House Monitoring" prepared by Buchan Lawton Parent Ltd. For copies of the report contact: R-2000 Program, Energy Mines & Resources Canada, 580 Booth St., Ottawa, Ont. K1A 0E4

Northern Housing retrofits

Fort Severn Housing Retrofit

Retrofitting can prolong the life of a house, making it easier and less expensive to heat, and a more comfortable place to live. If the retrofit isn't carried out properly, all the money invested may simply 'go up the chimney'. The Fort Severn Housing Retrofit Project showed there are a number of considerations to keep in mind when retrofitting northern housing.

Fort Severn

Fort Severn is a small Ontario community located on the south-west shore of Hudson's Bay. Winters can be long and harsh with more than 8,000 degree-days (°C), yet the majority of the existing housing stock does little to reflect this climate. Fifty-two of the sixty houses in the community were built prior to 1983. Typical construction involved 2x4" stick-framing, with little more than R12 in the walls, attic, and floor.

Discontinuous permafrost soils and improper foundation construction have resulted in differential settlement, creating cracks in the building shells. These factors in conjunction with poorly installed windows and doors, create drafty and uncomfortable living conditions.

The houses are heated primarily with wood. The use of non-approved woodstoves is widespread, a situation that is both inefficient in terms of fuel consumption, and unsafe for the users.

These conditions have resulted in high operation and maintenance costs, high wood-fuel consumption, and houses with a life span as low as ten years.

The Project

Beginning in 1985 with monies from Canada Mortgage and Housing Corporation (CMHC), Indian and Northern Affairs Canada and Remote Community Demonstration Program,

Before retrofit

the Fort Severn Band carried out a series of twenty-four retrofits over a three year period. Beyond the obvious benefit of making the houses more comfortable and energy-efficient, the retrofits were part of a larger effort to reduce fuel consumption and conserve local wood resources. The following measures were implemented in the retrofits:

** Original crawlspace structures were removed, replaced with preserved wood crawlspaces.*
** Glass fibre insulation was added to the floor to bring it up to R24.*
** One inch of semi-rigid insulation was added to the exterior to raise the insulation of the walls to R16.*
** New exterior siding was installed*
** R28 insulation was added to the attic for a total of R40.*
** Doors and windows were replaced with more efficient units, and in some cases, exterior storm windows were installed.*
** New woodstoves with insulated chimneys were installed.*

The amount spent on individual units ranged from $11,000 to $16,000.

Six houses (built prior to-1983) were monitored for a period of one year. Of these three had been retrofitted, the non-retrofits serving to create a data base for evaluation and comparison. The houses were monitored for indoor temperature and humidity, fuel wood consumption, foundation movement, air infiltration and air quality. In addition, interviews and visual inspections were carried out.

What was found?

While residents of the retrofitted units reported the houses to be more comfortable and easier to heat, the monitoring results show only a slight positive difference between the retrofit and non-retrofit houses.

* Indoor temperature and humidity data were tabulated for each home and correlated to wood stove performance. The data suggested only a slight improvement in energy-efficiency for the retrofitted housed.

* The differential movement of each foundation was monitored over the course of four site visits. While a small amount of foundation movement was recorded around the exterior, there was evidence of significant movement at the interior floor/wall area of two of the retrofits and two of the non-retrofits.

Heat loss through the floor is believed to have thawed soil around the centre beam, while exterior areas remained frozen, resulting in differential movement.

* To test for air leakage the houses were depressurized to 50 Pa using a blower door. The test results did not indicate a significant difference between the retrofit and non-retrofit houses. An average conventional home, properly retrofitted should have an air change per hour (ACH) of about 3.5. In Fort Severn the retrofitted houses averaged almost double this figure, registering a low of 6.6 ACH and a high of 9.8 ACH. The non-retrofitted houses averaged 9.0 ACH.

After retrofit

To pinpoint areas of air leakage, thermal bridging, and low insulation values, thermography tests were conducted before and during the air infiltration tests. Thermographic analysis of both the retrofitted and non-retrofitted homes showed large leakage areas around ceiling fixtures, through wall electric outlets and switches, and through attic hatches. Signs of moisture retention in the attic were also evident. On the positive side, the analysis did reveal significant thermal improvements associated with the new insulated cladding on the retrofitted units.

Conclusions

Although residents reported that the retrofitted houses were more comfortable, the monitoring results revealed that the retrofits did not accomplish all that they were intended to. Conversations with those involved in the project have identified four key areas that anyone undertaking a retrofit should do well to keep in mind.

1. The foundation

Unless the foundation is, or can be made structurally sound and stable, any differential movement will destroy the fruits of your labour. Discontinuous permafrost, such as that encountered in Fort Severn, poses a significant problem for foundations. The slightest deviation from recommended foundation design can result in differential movement.

2. Air sealing

Concentrate on fundamental energy conservation techniques. Any retrofit, minor or major, should begin with an intensive program of caulking, weatherstripping and, if possible, the provision of an air-vapour barrier. It is doubly important to seal all the leaks and seams in the building envelope. Not only does this help to keep the heat in, but it protects the building structure and the insulation from the damaging effects of moisture.

Too much emphasis has been placed on improving the thermal resistance of these structures, and not enough on the little measures that pay large dividends - sealing the leaks in the building shell.

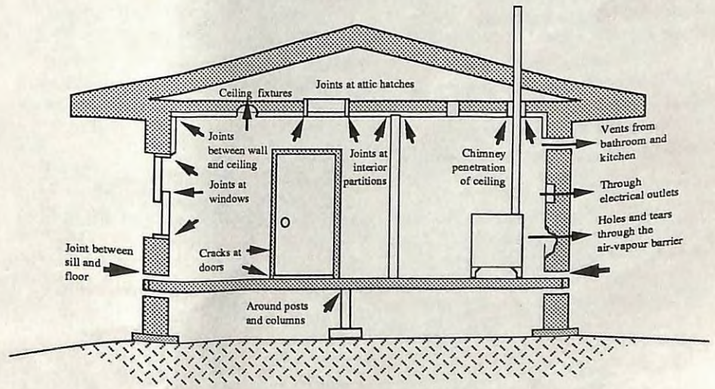
3. Check the house operation

While not directly tied to a retrofit, the operation of the house, especially the heating system, can often spell the difference between success and failure.

The wood stoves used in Fort Severn are a simple updraft design. On average this style of stove is 15% less efficient than other types. In addition, the occupants of the retrofitted units continued to burn wood at the rate which they were accustomed to before the retrofit. More efficient stoves, capable of high temperature burning should be selected for use especially in remote areas.

4. Don't retrofit unless it is worth it

Not all houses are 'retrofit candidates'. This is especially important when considering major measures such as those undertaken in this project. If the investment is going to outlive the structure, don't invest!


Ceiling fixtures
Joints at attic hatches
Joints between wall and ceiling
Joints at windows
Joints at interior partitions
Chimney penetration of ceiling
Vents from bathroom and kitchen
Through electrical outlets
Holes and tears through the air-vapour barrier
Joint between sill and floor
Cracks at doors
Around posts and columns

Potential Air Leakage Sites

The following list details energy-efficient modifications and measures that can form part of a northern retrofit. Ideally, all of the measures should be carried out. Where this isn't possible, those with the shortest payback should be carried out first. The list has been prioritized accordingly. After making sure that the foundation is structurally sound, consider the following improvements:

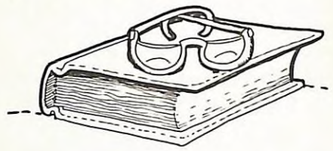
** The house should be thoroughly air sealed (caulking, weatherstripping) and where possible, an air-vapour barrier should be installed.*
** Once the house has been made tighter, make sure there is adequate ventilation for the occupants.*
** Add insulation to the floor (minimum R28).*
** Add insulation to the above-grade walls (minimum R25).*
** Add insulation to the attic (min R40)*
** Improve doors and windows (min. double-glazed with a ½" air space).*
** Make sure that the heating equipment has been sized properly and is functioning as it should.*

Keewatin-Aski Ltd (consulting engineers) estimate a cost of approximately $18,000 per unit to carry out these measures in Fort Severn, including transportation and labour. While this price tag might appear high, it is less than one-third the cost of building a new house. With the possibility of doubling the life span of an existing house, taking the time and effort to perform the retrofit properly can more than pay back the investment.

The work described was done as a project in the Remote Community Demonstration Program funded by Energy Mines and Resources Canada.

Building Environmentally Clean Homes

Richard Kadulski



We all enjoy the new gadgets that make our work and leisure more enjoyable. Many are thanks to the new compounds our technological society has created in the last few years.

In construction, we are using products that didn't exist 20 or even 10 years ago. But this development has a price that we are only now discovering.

The pollution of the environment, be it the emissions of the factories making these products or the garbage generated is a cost we have to come to terms with. There is another and that is what is known as ecological illness (or environmental hypersensitivity). There are no official statistics yet to tell us how serious the situation is but we know that it is becoming more widespread.

This is an illness not easy to pin down as symptoms vary from person to person. They may be acute or chronic, and vary from a minor nuisance to severe disability. An environmentally sensitive person reacts to very small exposures to pollutants, toxic chemicals, or seemingly harmless substances, depending on the material, the severity of the exposure, and the patient's susceptibility.

The sources are all around us. A study done for the U.S. Environmental Protection Agency found levels of toxic pollutants in indoor air up to five times higher inside houses than outdoors. This pattern was noted in heavily industrialized areas as well as in remote rural areas. The conclusion is that most Americans are living in toxic environments. In fact, the EPA studies *"show that there has been no fresh air in the U.S. for 20 years. Today, the best air available is found at certain sea shores, mountain tops, and in unpopulated areas"*.

Because of the similar conditions and construction practices, the situation would not be any different in Canada.

How serious is the problem?

Some estimates suggest that as much as 20% of the population may have some symptoms of ecological illness. What you consider a hay fever allergy, a lingering cold or chronic headaches just could be the result of environmental sensitivity. Symptoms may include unexplained weakness, swelling of eyes, hands, or feet, spots on the skin, impaired judgement or vision, memory loss, pains, headaches, depression, hyperactivity and nervousness. Generally, children and women are more sensitive that men.

The impact on families can be serious if the source of the stress is not recognized. Yet, it is difficult to diagnose because reactions are often unique to the individual. Before diagnosis, the individuals often are considered to be metally ill or hypochondriac.

Doctors don't start with an ecological illness perspective because they don't know enough about the subject. Many of the symptoms are similar to other identifiable ailments. It's when all other possibilities have been eliminated that ecological illness might be considered.

If a customer does not feel comfortable about a product or house, but can't quite pin it down, there just may be a valid reason (even if it can't be pinpointed accurately). It could be a reaction to some product in the environment.

Evidence seems to indicate that the illness can be reversed as long as the person suffering can escape to a clean environment. Generally, it means providing a clean room for the person to get away from the toxic sources.

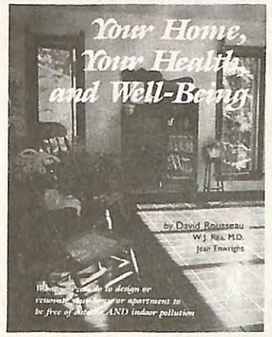
In **Solplan Review** No. 16 we reviewed some of the key issues in environmentally clean environments.

The most important feature of the clean home environment is an absence of pollutants - in other words you try to remove the source of pollution rather than trying to clean it up after it's in the house. It sounds easy, but how do you go about it?

If you go to your local building supply dealer and start to ask questions about the chemical make-up of the materials you'd get blank looks. Assuming the sales people were willing to try and answer your questions, they wouldn't find the answers quickly, as manufacturer's literature doesn't get involved with that kind of detail.

2 recent books deal with the issue of the non toxic home environment. Both have been written for a non specialist audience so you won't find a lot of medical or scientific jargon.

Your home, Your Health, and Well-Being by David Rousseau, W. S. Rea, and Jean Enwright is written in a clear and concise manner. It is an excellent guide to healthy home design, as it discusses the environm



ental factors in the home and how to assess them. Design principles and practical details for preventing problems are presented.

To avoid repetition, there are many cross references. In addition to a standard table of contents and index, there is a listing of health and comfort factors for each room, indicating location of detailed material (air quality & ventilation; lighting; thermal comfort; sound control; others).

Perhaps the single most valuable feature of this book are the tables listing building materials, with a rating-for-safety based on the usual chemical properties of each material.

David Rousseau is a graduate architect with a special interest in environmentaly clean building design.

W.J. Rea is a medical doctor who is a specialist in environmental medicine.

Jean Enwright is a chemically sensitive person. Her personal account describes her symptoms and the difficulty she had in having her condition diagnosed. There were so many, it was difficult to recognize a cause and effect.

She writes *"hoping to be helped, I went to another doctor who specialized in prevention. As I became sicker and sicker on his prescribed remedies, he became more impatient with me.*

I had become quite wary of the medical profession as I became sicker and sicker without being correctly diagnosed"

Unfortunately, this is a common problem for the chemically sensitive.

For her, the long road back to health began as she started to isolate products that are toxic to her. One of many contaminants that affected her were the fumes from the natural gas fired forced air furnace in her house. The solution was replacing the furance with a unit which had combustion outside the house.

Your home, Your Health, and Well-Being is an excellent book, but the major concern I have with the solutions offered is the excessive reliance on passive ("natural") ventilation.

Air flow to flush the home clean is an important factor in removing the pollutants. However, passive ventilation (i.e. cross ventilation from open windows) will not do an adequate job as it depends on ideal weather conditions. For too long a time during the year there just are no driving forces for the passive ventilation.

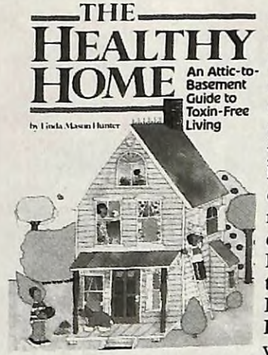
Controlled mechanical ventilation does not mean that you can't open windows. It just means that you will always have a known air flow.

Part of the problem for the lack of understanding of how poorly passive ventilation works may be due to the fact that mechanical ventilation (and suitable equipment) for residences is a relatively recent development. Good quality equipment has only become available recently.

HRV'S are only one approach.

Linda Hunter saw the EPA report on toxic pollutants in homes and began to wonder how healthy her own house was. The first thing she had to do was find what it was one looked for.

The Healthy Home: an Attic to Basement Guide to toxin free living is the book she wrote. It covers much of the same territory as Your Home, Your Health.



This book is put together like a collection of shorter pieces, so you don't have to sit down to read it at one sitting. However, the Healthy Home is very readable, with many anecdotal references.

As you start reading, it terrifies you, and you don't really want to put it down until you have an idea of just how bad the problem is. The examples bring home the significance of the potential problems.

"Today, 6 billion pounds of formaldehyde are used in the U.S.A. each year. It's found in practicall every home - in drapes, upholstery, adhesives used in carpeting and wallpaper, milk cartons, car bodies, household disinfectants, permament press clothing, and paper towels, to name only a few common products. But the major source of formaldehyde contamination is pressed wood products...as much as 10% of the average sheet of particle board, or medium density fiberboard ... may be formaldehyde"

But it's not just negative scare stories, there are many solutions are offered.

The Healthy House starts with a house health audit, going room by room, starting in the attic going through to the basement and also the yard and garage. Each area is cross referenced to parts of the book where the issue is discussed in detail.

Unfortunately, like Your Home, Your Health, the author places too much reliance on passive ventilation.

A second shortcoming is that there just is not as much clear cut information about materials and their properties.

Both books are worth looking at.

Your home, Your Health, and Well-Being *by David Rousseau, W. S. Rea,*

and Jean Enwright; published by Hartley & Marks; $19.95

The Healthy Home: an Attic to Basement Guide to toxin free living *by Linda Mason Hunter; published by Rodale Press; $26.95*

Both books are available from Solplan Review. Please add $.75 per book for postage & handling ($1.50 each if outside Canada).

Letter to the editor

Sir,

I have been a subscriber for several years and am an avid reader of your newsletter. My wife and I have lived in one of the Ontario Ministry of Energy Ultra-energy Efficient Airtight demonstration homes program since 1982 (it predates the R-2000 program). As our family is expanding, we are building a larger home of R-2000 quality as we would not live in any other type of home.

I have closely followed your recent issues on mechanical ventilation. It is a subject on which I have performed some research over the past five years. My co-researcher, Mr. Darel Mesher and I have developed an intelligent, automated computer control for air handling devices. It has been tested over the past two years with resounding success. It provides for user comfort (customization), energy conservation as well as adhering to ventilation guidelines at all times.

This device can deliver automated control of ventilation devices so as to utilize "optional capacity related to special needs, rather than continuous operation" and thereby increase owner comfort and energy conservation simultaneously as you so eloquently put it in your "Commentary on CSA F326.1", (Solplan Review, April/May). I cannot agree with you more.

I plan to contact the committee responsible for CSA F326.1 to indicate that incorporation of intelligent computer control can solve problems while adding much user taylorability for comfort without sacrificing health ventilation operation.

W. F. Poelhman
Dept. Computer Science
McMaster University
Hamilton, Ont.

Scandinavian Diary

This could be a "what I did on my summer vacation" story. I'll resist (but it was a delightful couple of weeks!). As our Northern readers know, there is something stimulating about the long hours of sunshine of the northern summer. (Yes the weather was nice, and it got to 30°C in Oslo).

My trip to Denmark, Norway & Sweden was much too short and very much a pleasure trip, but it's hard to avoid falling into the occupational hazard of looking at buildings. This is not a formal report, but just a few random thoughts and observations.

The location

Denmark (the furthest south) lies north of 55°N (Copenhagen is at 55°30'N, Oslo is at 60°N). In Canada, Edmonton (the furthest north large city in Canada) is at 53°30'N, Whitehorse is at 60°45'N. Because of the Gulf Stream, these countries are kept much warmer than northern Canada at the same latitudes.

We tend to see Scandinavia as one country. While they have much in common, and the languages are similar, there is much that sets each one apart. A Dane or Norwegian will remind you that they are not a Swede! (and vice-versa).

What is impressive is that while the population is small (Denmark 5.3 million; Norway 4.2 million; and Sweden 8.5 million) these countries have had a far greater influence on the world than their size would suggest.

We've heard about the socialist experiments, about the cradle to grave welfare system, and the high tax rates. It's all true, but it has not stifled initiative.

Free enterprise is alive and well! Names such as, Volvo, Husqvarna, Hasselblad, SAAB, Bang & Olufsen and Electrolux are just a few of the companies we are familiar with that call Scandinavia home; all are private investor owned enterprises.

Scandinavian countries are noted for their high incomes and high standard of living (higher than in Canada). The standard of living is enjoyed by all (you just don't see the slums and homeless that even we in Canada & the USA tolerate). But this has come at a price - the tax rates are high (everyone pays!), so is the cost of living. Even food is taxed. The minimum wages are very high, so that even someone earning minimal wages can survive at a decent (but far from luxurious) standard.

Housing costs

House prices are high, so financing programs have been developed to provide access to housing. In Denmark realty offices not only list the property price (a 1000 sq.ft. house or apartment for Can$100,000 is cheap), but also gross and net monthly payments. Net monthly payment is important as there are various tax rebates and subsides to make homes accessible.

The emphasis is on financing programs that provide access to housing. Thus mortgages often run for longer terms than the 20-25 years we are used to.

Because of the high standard of schooling and restrictive labour laws (you can't hire and fire people at short notice, like we do) manufacturers have been spurred to develop sophisticated and advanced processes and products that take advantage of the well educated workforce.

Automated Swedish factory housing was developed because of these labour restrictions. In the process, the product is now the standard envied in the world.

Housing Design

The favoured housing form is the single detached house, but about half the housing units are multiple family dwellings. The high-rise apartment is rare - most apartment buildings are what we would consider garden apartments (2-4 stories high).

The size of singe family houses is smaller, a 1000-1300 sq.ft. house is typical, 2100 sq.ft. is large (basements are not common).

Layouts are similar to what we are used to; a large entry is common, while the kitchen and bathrooms are smaller. The bathroom is still very much a functional room. A house or apartment with more than 1 or 1½ baths would be the exception.

Kitchens are smaller, have a clean crisp design, yet do not look or feel cold or stark. One commonly found feature I liked was the stainless steel sink/counter unit. The sink is part of a counter that may be as long as 6 or 8 feet, the whole unit having a slight slope draining into the sink. It's functional and easy to clean!

Housing designs are perhaps more conservative than we may be used to. The "flavour of the month" design mentality does not apply. As a result, there is more uniformity in housing styles. But it is no more uniform or boring than what we have. Just look around the new subdivisions, even those where the houses scream out to be noticed - there really are few differences between them!

Norwegian housing most closely resembles the styles and finishes that we see in Canada with wood frame construction and wood siding (in a range of colours).

Norway has a tradition of timber houses and sod roofs - so you sometimes see sod used in new houses (but because of the structure needed it's very much the luxury material).

Roof pitches tend to be steeper (1:1 is quite common) with the attic developed into finished living space.

Fuel fired appliances, including woodstoves and fireplaces are common (especially in Sweden and Norway) but they *always* are on the inside, in the centre of the building. You just don't see the fireplace on the outside wall.

Codes require that solid fuel appliances have access to the flue for cleaning, so on newer houses you see ladders built into the roof.

Attention to detail is a hallmark of Scandinavian design. We know about Danish furniture design and IKEA has become synonymous with Swedish furniture. It really is standard fare. In home furnishing stores you just don't see the overdone "styles" that go out of fashion every few months.

Norwegian Building Research Institute

The Norwegian Building Research Institute (an independent, non-profit, industry supported foundation) is the national centre for building research, product testing as well as providing information and trouble shooting services.

What impressed me is their information program. They publish two Building Research Series. These illustrated information sheets cover building details and design and planning topics. There are over 460 in each series, in a loose leaf format (easy to update as needed; typically 50 new and updated sheets are issued each year). Distribution is by subscription and they have over 10,000 subscribers in Norway, at well over $150 per year, per series!

The **Norwegian Building Code** (for all building types) is a performance code. It is a slim book with just over 100 pages. There are no tables or pages of references to standards (that hardly anyone really understands or has ever seen) as we are used to; just statements of what must be provided in a building. How it is done is left up to the owner who must ensure that competent professionals will execute the construction in a safe manner. Yes, there are still building inspectors around (and I am sure they have just as many run-ins with builders and designers as we do).

Swedish building

The industry has created a positive image about themselves, and they've received a good press. Swedish housing is often regarded as the ultimate in state-of-the-art technology and quality.

What we see are their best export quality products. They are commonly used at home, but are not used universally.

The factory crafted housing with its quality control features definitely helps ensure a high standard. However, they are not necessarily better than our good quality construction.

High-tech windows? While the latest technology is available, most commonly wood framed, standard double glazed windows are used with an exterior storm window. Aluminum frames are only used in large commercial jobs, and even there, wood frames are common.

Most windows are either centre pivoted, or casement. I didn't notice any screens, so I guess that bugs are not a problem in most areas!

Ventilation requirements

Contrary to belief, mechanical ventilation is not mandatory in Sweden (except for multiple dwellings over 10 units) even though it is frequently used. Passive ventilation is common in single family houses, and yes, they are having moisture problems in houses that rely on passive ventilation only.

Ventilation rates (.5 air changes per hour) have been determined based on studies first started in England in the 1930's, and confirmed over time by trial and error. It is meant to control moisture, odours, offgassing and to provide fresh air. The common size of most dwellings means the air change rate based on total house volume (rather than occupancy) is reasonable.

Very quiet kitchen fans are available. In one apartment, I noted that the exhaust hood was set up to run continuously at low speed. You could shut it off by deliberately closing a duct damper. At slow speed, unless you really searched for it, you didn't know it was running. At high speed, you really have to strain to hear the fan.

The most common heating system is high temperature hydronic (with radiators), heated by electric boilers. Forced air heating systems are almost unheard of.

Richard Kadulski

Odds 'n Ends

Ventilation B.C. HRAI-BC Course

Recently we reported on the ventilation code course prepared by the B.C. Chapter of HRAI. It was developed as a result of concerns that arose when the ventilation requirements of the B.C. Building Code were enacted last November.

There was a lack of understanding on the part of the trades and inspection authorities as to how to comply with the code. Completion of the 6 hour course does not mean that the trades know all there is to know about residential ventilation. By design it focuses on code compliance only. This means that in many cases only basic (and not necessarily the best) ventilation schemes will be installed.

The course tends to be academic, dealing with the code language and little practical hands-on activity. The positive feature is that it exposes the trades to the fundamental issues involved, and creates a good stepping stone for future improvements.

The manual prepared specifically for this course explains by means of simple flow charts the decisions that must be made to select a ventilation system for a specific house.

The course is open to mechanical trades, as well as building inspectors, utility representatives and builders.

The course has a written exam (an alternative to the written exam is an oral/site inspection), and those in the heating/ventilating industry who are successful receive a certificate and stamp. This will help authorities identify installers who have proven an understanding of code requirements.

Most building departments in the Greater Vancouver metropolitan area have agreed to recognize graduates of this course. It is hoped this will also happen in other parts of the province.

To date over 140 persons have taken the course. About 60% have been mechanical trades, the balance include utility representatives, building inspectors, and system designers. The pass rate is around 90% of those taking the exam.

The course fee is $125.00. For more information call HRAI-BC Chapter at (604)-299-6508.

Courses scheduled at this time (all in the Vancouver area):
- September 26 & 28 (evening)
- September 30 (all-day)
- October 17 & 19
- October 28 (all-day)
- November 7 & 9
- November 21 & 23

Breatheasy 4500 Air Cleaner

There is a new room air filter on the market that may be useful for people with sensitivities to dust, mould, and smoke.

The unit is a stand-alone filter, styled to look like a black speaker cabinet. It has a high air flow (75-450 cubic feet per minute) and a hundred square feet of HEPA filter, which provides the highest standard of particle filtration without producing ozone.

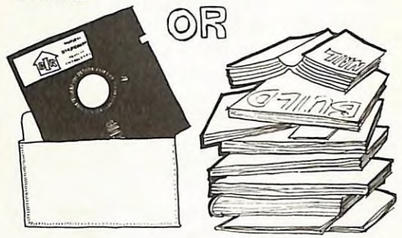
This filter will not be adequate for those who have severe chemical sensitivity. They may be better off with other filters using activated carbon to scavenge odours not associated with particles.

HEPA filtration was developed by the U.S. Atomic Energy Commission specifically to filter out dangerous small particles. To meet the HEPA standard the filter media must remove a minimum of 99.97% of all particles in the air down to .3 microns and the efficiency must improve with use. It is the only filter media universally recognized as being able to do this job and is used in virtually every scientific, medical and industrial application where clean air is critical.

It retails for $350.00

For information:
HEPAfilter Ltd.
3663 Mavis Rd. Unit 7
Mississauga, Ont. L5C 2Z2
Tel: (416) 566-5660

Building & Remodelling Index



You are having a problem on the job. You're not sure what the problem is, but you recall seeing a write-up on something like it a year or so ago. Unfortunately, you don't remember where you saw it.

You need the information, so you go to the pile of magazines at the back of your office and start searching. After a whole evening, you realize you've only gone through half the pile. You begin to wonder: "why am I doing this? There's got to be a better way!" Sound familiar?

It's not possible to read all the publications that deal with construction, but they all have valuable material. Now there is something better!

Building & Remodelling Index is a data base covering the light construction & remodelling field. Over 1500 items per year from over 40 magazines, newsletters and government sources in North America are reviewed.

It uses PCFile+ data base software (included in the package). Start-up and browsing through the data is quick and easy. A good instruction manual is included, as is a subject index explaining how data is catalogued. Each entry contains a summary describing the key points in the story, details of source, author and number of pages.

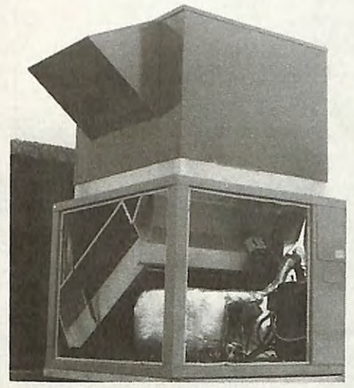
An interesting feature is the reprint service. If you find something from a source you don't have, but think it will be useful, you can order the item (ordering information is provided).

It appears to be a comprehensive index, well done, but one flaw is that not all items from all publications are indexed. But it still is a valuable tool to anyone on the building industry.

BRI is available by subscription (quarterly updates on a disk) for both IBM-PC and Macintosh computers at $97.00 per year. The start-up package includes the file management software plus data from 1984 to 1988 and costs $119.00 (IBM) and $169.00 (Macintosh). An annual reference book is $40.00

For information:
Building & Remodelling Index
Box 7466, Portland ME 04112
Tel: (207) 871-7066

The heat recovery water heater



HeaTrade Inc. has introduced the AIRWATT Heat Recovery Water Heater. It is a packaged heat-pump system that heats hot water from waste heat contained in building air, (even at room temperature).

This is not a unit for single family dwellings (unless you consider Buckingham Palace or the Playboy Mansion as a single family dwelling).

It can be used with existing rooftop exhaust fans. Water lines are attached to move the heated water to where there is a demand for hot water. Space-heat and make-up air heat can also be provided if required.

This unit allows economic heat recovery year round from exhausted air in situations where it was not previously feasible.

Heat recovery from internal sources of waste heat such as boiler rooms, over-heated equipment rooms and industrial processes is also possible.

Monitoring over the past two years has shown that the AIRWATT will have a payback of 3 to 4 years when displacing gas, and 1 to 2 years when displacing electricity.

When it is recovering heat, it cools the airstream. The unit thus provides air-conditioning while it heats water. It's "free" air conditioning because the savings in water heating costs will more that pay for the operating cost.

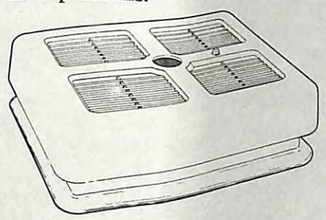
Water-cooled air-conditioners do exist but they aren't designed to heat potable water up to the temperatures required nor do they use the double-wall heat exchanger which is necessary.

For further information contact:
Dara Bowswer, Sales Manager
HeaTrade Inc.
368 Phillip Street
Waterloo, Ont. N2L 5J1
Tel: 519-884-6321

Gas & Smoke Detector

Standard detectors only detect smoke, but smoke is not the only potential hazard in any building. There are other toxic and combustible gases that can build up especially if there are combustion appliances in the building.

Gases can accumulate due to clogged or improperly vented flues, faulty or damaged heat exchanges, or other similar problems.



BDC Electronics Inc. has developed the ULTRALERT system, a unit that senses smoke, carbon monoxide (at 300 ppm) and methane (natural gas) at a level below 25% of the lower explosive level.

The unit has two sensing elements. Smoke is detected with an ionizing sensor; gas with a sintered tin oxide semi conductor sensor. The alarm varies depending on whether it is sensing smoke or gas.

The unit operates off 120 v AC power, is equipped with a 9 volt battery back-up and can have up to 12 stations.

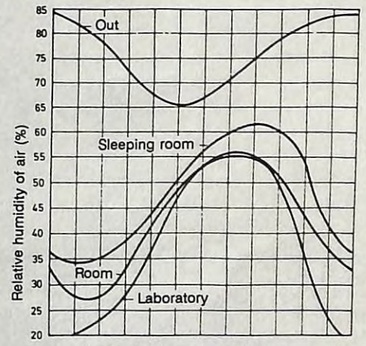
Other gas sensing equipment is available, but most is laboratory grade, sensitive and costly. This unit provides a measure of security that is affordable in a home or office. It retails at about $150.00 U.S., and is listed with Underwriters Laboratories.

For information:
BDC Electronics Inc.
Box 4496, Midland, Texas 79704
Tel: (915) 694-7887

Humidity through the year

While the ideal relative humidity (RH) conditions for people are considered to be 40-60% RH, there will be variations over the year. This can affect how materials sensitive to humidity perform, as well as to conditions inside a building.

These graphs show the variation that can occur over a year. The actual numbers may vary depending on location (these are from a Norwegian source), however, the general pattern is constant. It explains why ventilation systems will work harder in the fall than at other times of the year.



An example to the variation of moisture content in wood, measured on exterior cladding and interior woodwork, and in a house and laboratory.

In 1982 David visited the leading
North American HRV manufacturers.
He selected the vanEE based on
the quality of the product and the
people behind the product.

Our thanks to Rick Olmstead and all
the staff at Conservation Energy Systems.

We've never once regretted our decision

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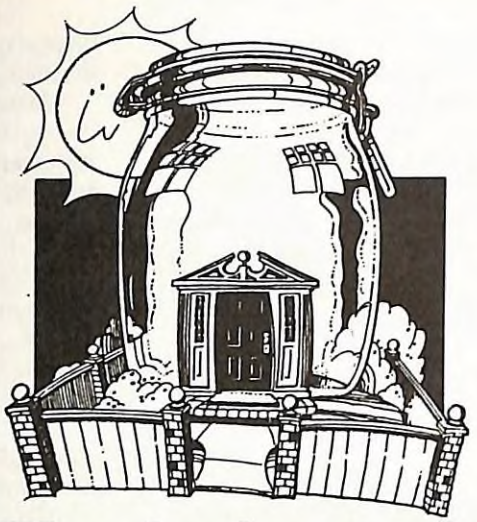
B.C. BUILDER'S FORUM

A week long forum featuring workshops of special interest to the building industry is being organized in Vancouver for October 30-November 3, 1989. A total of 23 workshops, ranging in length from 3 hours to 5 days are being scheduled. Topics include Certified Professional Builder; Business Management; Stress Management; Quality Plus; Legal Issues for Builders; and more. For full details call Yvonne at (604) 430-5994.



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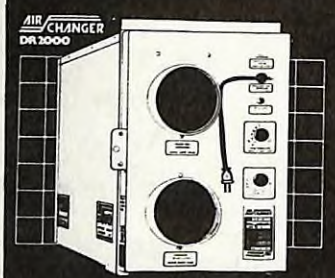
AIR CHANGER®



THE ENERGY EFFICIENT FRESH AIR SYSTEM™

- *High energy recovery (efficiency).**
- *High temperature recovery (effectiveness).**
- *Widest range of airflows, efficiencies, control options to suit your home's individual requirements.*
- *Energy efficient electronic demand defrost system.*
- *High quality thermally broken double shell case construction.*
- *Easy-access panels for service from either side without core removal*

* *According to independent lab. testing to CSA standard C439M.*
For further information, call or write:

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